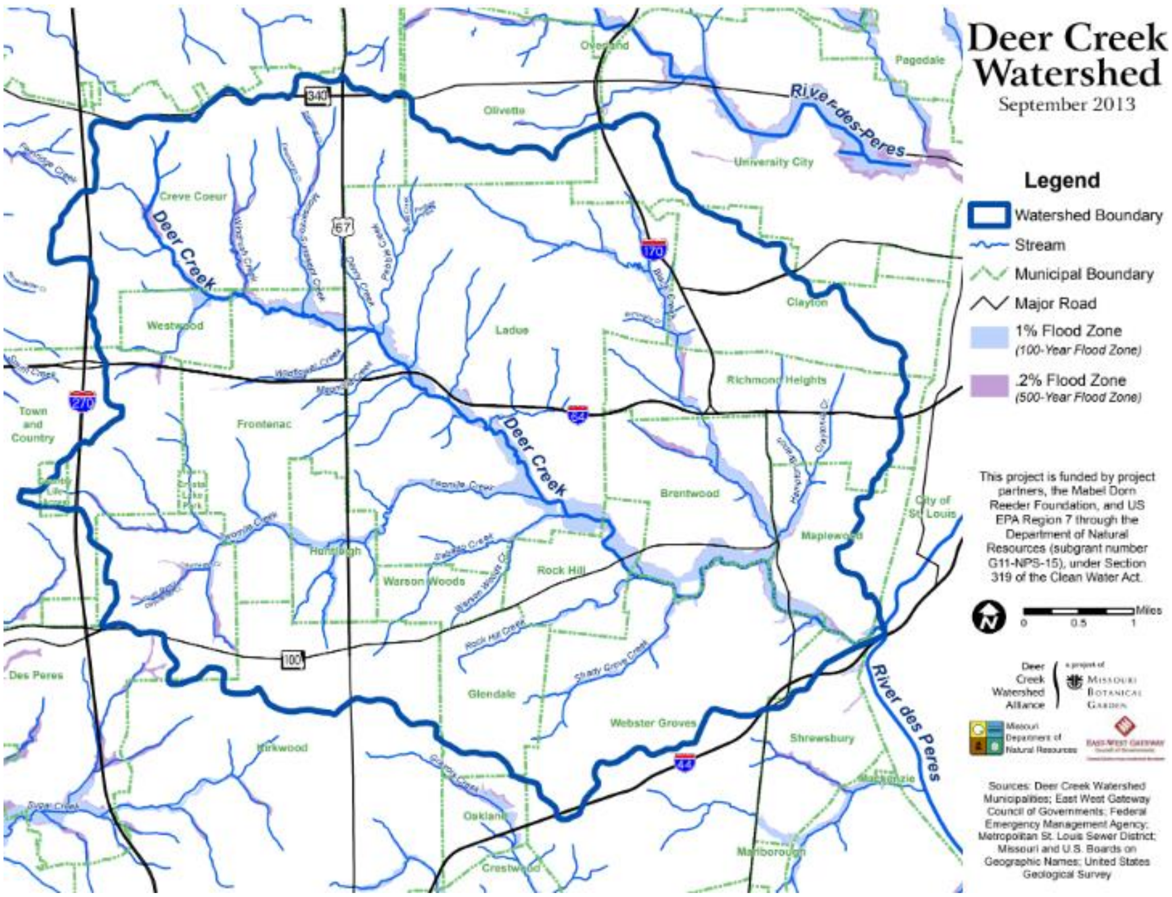
CHAPTER 2 – WATERSHED DATA INVENTORY

2.1 WATERSHED DESCRIPTION

Deer Creek is an urban stream in St. Louis County and western St. Louis and is a tributary to River des Peres. Deer Creek originates in north central Creve Coeur, south of State Highway 340, and flows southeast for approximately 10.75 mi (17.3 km) before entering the River des Peres in St. Louis. The Deer Creek watershed drains approximately 36.8 mi^2 (95.3 km^2) and intersects twenty-three municipalities (Map 2-1). Deer Creek is identified in the Missouri Use Designation Dataset as water body identification number, or WBID, 3826.

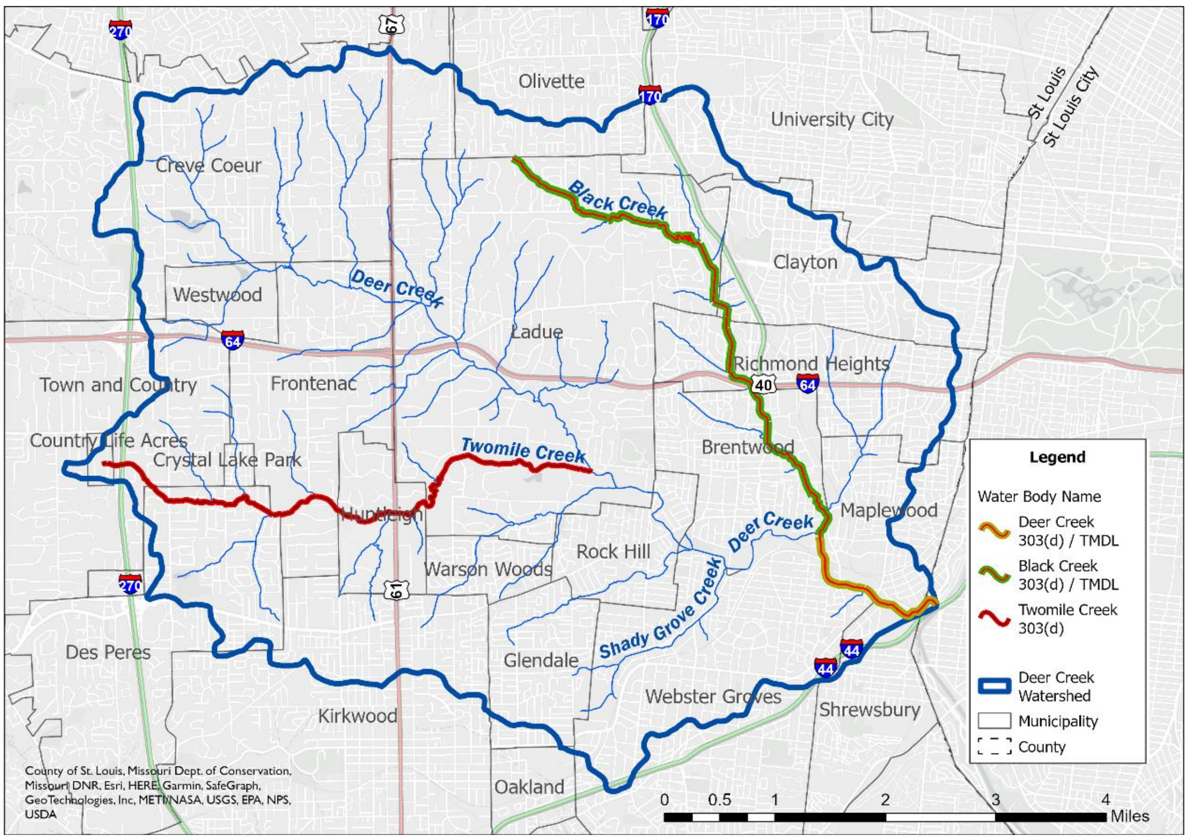


Map 2-1. Deer Creek Watershed Streams
Source: East-West Gateway Council of Governments

The major contributing streams within the watershed are Deer Creek (stream order 4), Black Creek (stream order 3), Twomile Creek (stream order 3), Sebago Creek (stream order 2), and Shady Grove Creek (stream order 2). Black Creek is identified in the Missouri Use Designation Dataset as WBID 3825. Black Creek originates in north Ladue and flows south for 5.6 mi (9.0 km) until it joins Deer Creek forming the municipal boundary between the cities of Brentwood and Maplewood (Map 2-1). For several miles above Twomile Creek, Deer Creek is a third order stream. In a 1993 report from the

Litzsinger Ecology Center (LREC), which is located five miles upstream from the confluence with River Des Peres, Deer Creek is described as perennial stream although in "mid- summer when precipitation is least and evapo-transpiration is highest" it may experience only intermittent pools (Ochs, 1992). Stream order is determined by the number of tributaries a stream or a stream network has flowing into it. First-order streams are the smallest and are also referred to as tributaries or feeder streams.

Two Mile Creek is identified as impaired to *E. coli* on the 2020 303(d) list. A Total Maximum Daily Load (TMDL) report for *E. coli* for Deer Creek and Black Creek was approved by the U. S. Environmental Protection Agency (EPA) in 2019 for the lower 1.6 miles of Deer Creek and Black (Map 2-2). Summary statistics have been developed for the Deer Creek watershed, of which Black Creek is a subwatershed, and are presented in the Bacteria TMDL report, which was approved June 26, 2019. [1]



Map 2-2. Impaired segments of Deer Creek, Black Creek, and Twomile Creek within the Deer Creek Watershed

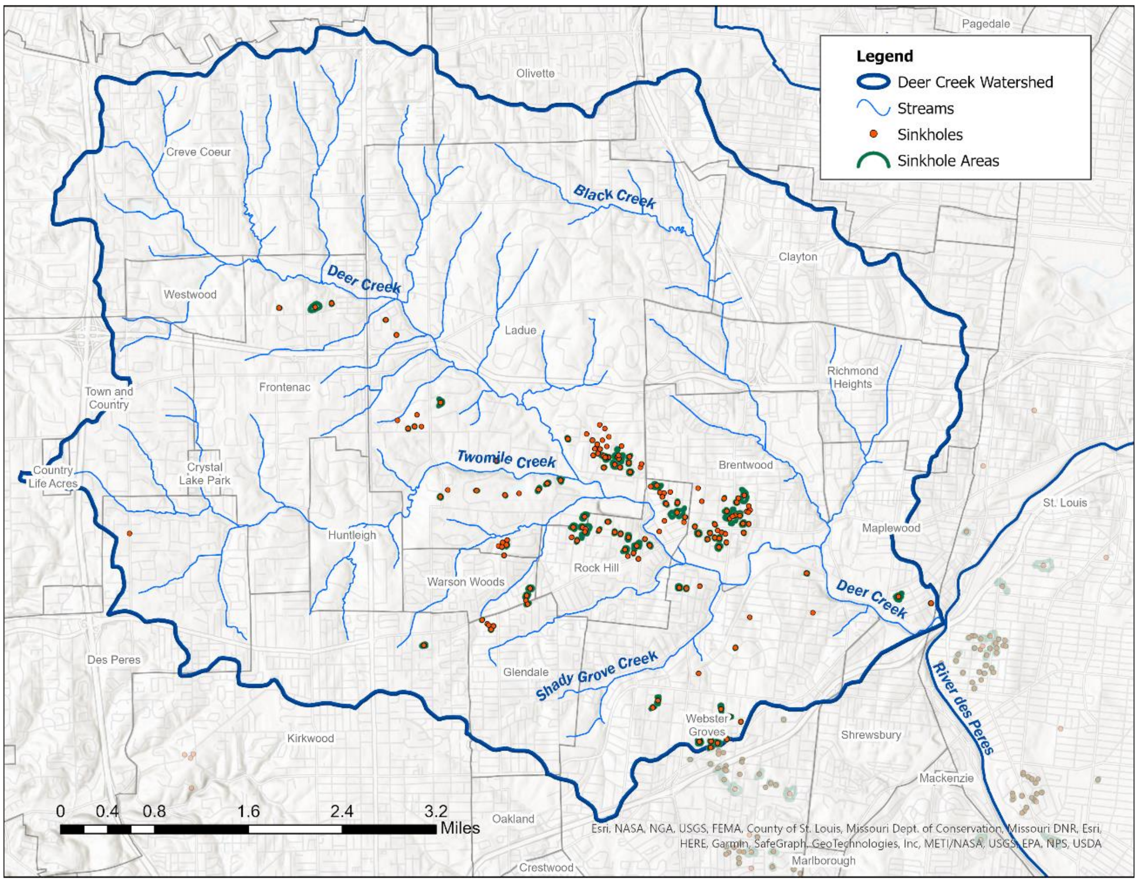
2.2 Terrain

2.21 Geology

Deer Creek watershed is a portion of the larger Cahokia-Joachim subbasin, identified by the 8-digit hydrologic unit code, or HUC, 07140101, which in addition to Missouri, lies within portions of Illinois.

[1] Appendix 2-A Bacteria TMDL pg. 2

The Missouri portion of the Cahokia-Joachim subbasin is located within the Apple/Joachim ecological drainage unit (MoRAP 2005). Ecological drainage units are groups of watersheds that have similar biota, geography and climate characteristics (USGS 2009). The characteristics of an ecological drainage unit are varied and are partially based on the ecoregions that are contained within the drainage unit. Ecoregions are areas with similar ecosystems and environmental resources. A level I ecoregion is a coarse, broad category, while a level IV is a more defined grouping. The Deer Creek watershed is contained entirely within the River Hills ecoregion. This area is a transition zone between the Central Irregular Plains and the Ozark Highlands. Key characteristic features of the River Hills are loess-covered hills and numerous karst features (Chapman et al. 2002). Karst features in the Deer Creek watershed include 147 sinkholes (MoDNR 2014[2]; Map 2-3).



Map 2-3. Karst areas and sinkholes within Deer Creek Watershed

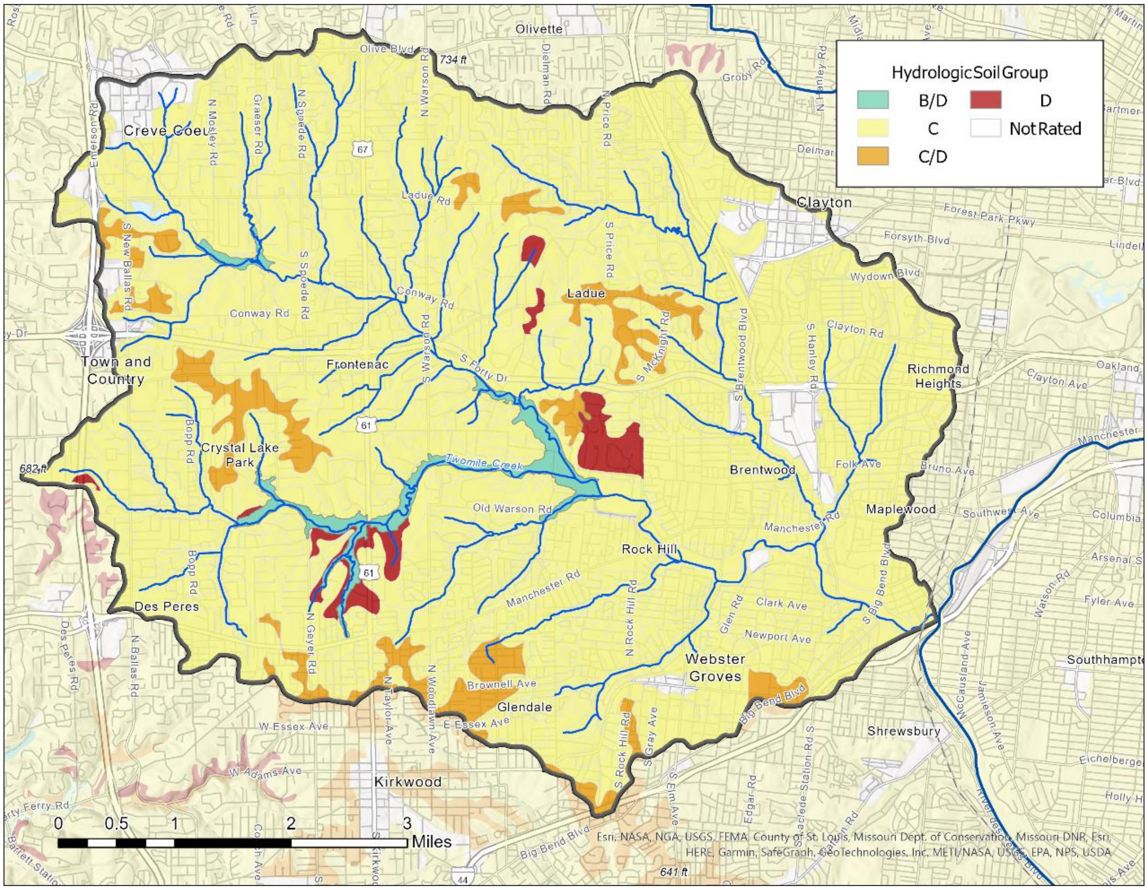
2.22 Soils

Soil Groups

Hydrologic soil groups categorize soils by their runoff potential and considers the rate at which water enters the soil profile under thoroughly wetted, bare soil surface conditions. Group A represents soils with the highest rate of infiltration and the lowest runoff potential under these conditions;

[2] Appendix 2-A Bacterial TMDL pg 3

Group D represents the group with the lowest rate of infiltration and highest potential for runoff (NRCS 2007). In some cases, soils are placed in dual soil groups based on both the depth to the water table and the soil's ability to drain. Map 2-4 below shows the distribution of these hydrologic soil groups throughout the Deer Creek watershed. [3] Table 2-1 provides a summary of hydrologic soil groups in the Deer Creek watershed.



Map 2-4 and Table 2-1. Hydrologic soil groups in the Deer Creek Watershed (NRCS 2011)

Soil Group:	***Dual Group B/D***	***Group C***	***Dual Group C/D***	***Not Rated***	***Total***
Approx. Area: mi² (km²)	0.4 (1.1)	29.3 (76.0)	4.6 (11.9)	2.4 (6.3)	36.8 (95.3)
Percentage:	1.2	79.7	12.5	6.6	100.0

The dominant soil group in the Deer Creek watershed is Group C, which represents about 80 percent of the watershed. Group C includes sandy clay loam soils that have a moderately fine to fine structure. Soils in this group consist chiefly of soils with a layer that impedes downward movement

[3] Appendix 2-A Bacteria TMDL pg. 3

of water. In the Deer Creek watershed, more than 12 percent of the watershed area is categorized as dual group C/D soils, which have characteristics of Group C soils but with a high water table that is typical of Group D soils. Similarly, a small portion of the watershed is categorized as being in the dual group B/D, indicating the soils have characteristics of Group B soils and also maintains a high water table like Group D soils. Group B soils include silt loam and loam soil textures, which have moderate infiltration rates. These soils typically consist of well-drained soils with moderately fine to moderately coarse textures. Approximately 6.6 percent of the watershed area could not be rated in a hydrologic soil group. Typically, areas that are unrated are composed of open water, quarries or landfills. In the Deer Creek watershed, areas that are not rated also include areas with soil types described as being greater than 90 percent urban and thus have a very high potential for runoff.

Soil Types

Considering more specific soil types, much of the northern portions of the River des Peres watershed include soils in urban classes, which generally have low permeability and high runoff. Fishpot soil series, which have moderately low permeability, occur close to the river. Menfro soil types with silt and loam mixtures and moderate permeability occur in various areas throughout the watershed, sometimes with karst features. Winfield soils with moderate permeability also occur near Deer and Mackenzie Creeks in the River des Peres watershed.

Approximately 50 to 60 percent of the Deer Creek sub-watershed consists of upland, which are classified as the Menfo-Winfield-Urban land association by the USDA-SCS (Table 2-2). This classification consists of gently sloping to very steep slopes, and well drained and moderately well drained soils. The remaining 40 to 50 percent of the watershed consists of the Urban land-Harvester-Fishpot association. This classification consists of nearly level to moderately steep slopes, and somewhat poorly drained to moderately well drained soils. (Source: CH2MHill Deer Creek Watershed Study for MSD).

The particular combination of soils, topography and underlying geology of this watershed present unique challenges that need to be carefully considered in the selection, design and implementation of the methods employed for effective stormwater management. Many of the soil types in the watershed are characterized as having slow or very slow infiltration rates, which significantly limit stormwater volume reduction though ground infiltration.

Low infiltration also reduces the bio-remediation of organic and inorganic contaminants and pollutants in stormwater. The ability of these soils to support plant material can be further degraded due to compaction from construction activities. As a result, some soils in the watershed may need to be amended or restored in order to achieve the intents of the best management practices (BMPs), such as reducing stormwater runoff and improving water quality by elimination of contaminants.

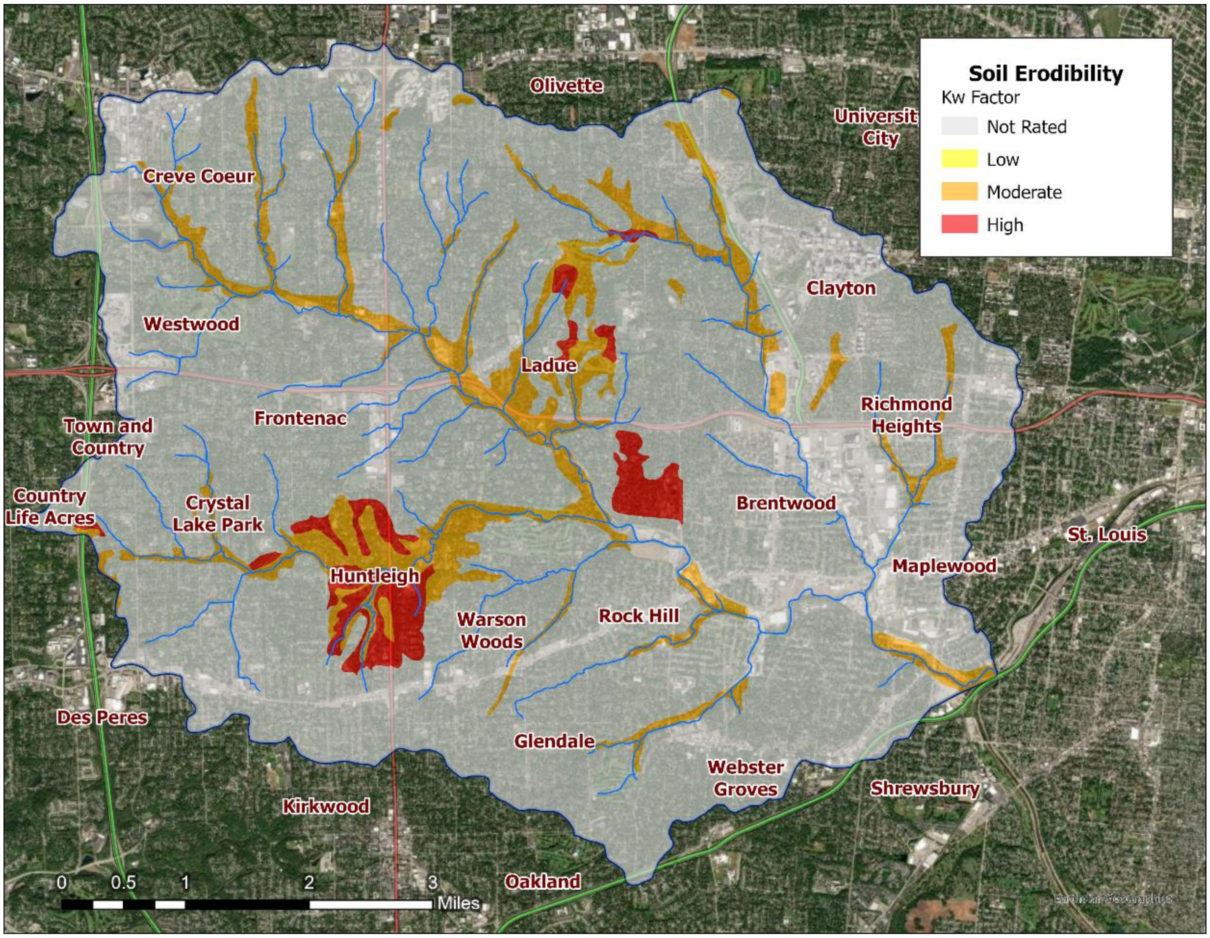
Table 2-2. Summary of soil types within the Deer Creek Watershed
Source: East-West Gateway Council of Governments

Soil Type	Acres	Percent
Fishpot-Urban land complex, 0 to 5 percent slopes	1,587	6.75%
Iva-Urban land complex, 1 to 3 percent slopes	1,305	5.54%
Menfro-Urban land complex, 5 to 9 percent slopes	560	2.38%
Urban land, bottomland, 0 to 3 percent slopes	545	2.32%
Urban land, upland, 0 to 5 percent slopes	889	3.78%
Urban land-Harvester complex, 2 to 9 percent slopes	5,394	22.92%
Urban land-Harvester complex, 9 to 20 percent slopes	2,875	12.22%
Urban land-Harvester complex, karst, 2 to 9 percent slopes	1,279	5.43%
Wilbur silt loam, 0 to 2 percent slopes, frequently flooded	276	1.17%
Winfield silt loam, 9 to 14 percent slopes, eroded	245	1.04%
Winfield-Urban land complex, 2 to 5 percent slopes	1,980	8.41%
Winfield-Urban land complex, 5 to 9 percent slopes	3,654	15.53%
Winfield-Urban land complex, 9 to 20 percent slopes	1,509	6.41%
Other –individually less than 1.00%	1445	6.10%
Total	23,543	100%

Highly Erodible Lands

Soil erodibilty describes the potential for a soil to be eroded by the direct impact of raindrops and by runoff. Soil properties that influence the susceptibility of a soil to erosion include soil texture, soil structure, and organic matter content. These soil characteristics influence the rate at which water enters the soil surface, the rate at which water percolates through the soil profile, and the water storage capacity of a soil. Fine textured soils with greater clay content are more resistant to detachment and have lower erodibilty values; coarse textured soils may be more easily detached but also have low erodibilty values because of low runoff rates. In contrast, the most erodible soils are those with high silt contents. Silty soils easily detach and also can produce greater rates and volumes of runoff, especially when soil crusting occurs.

Where steep slopes or pavement can convert 90 percent of rainfall to runoff, highly erodible land is subject to erosion and will subsequently deposit this sediment at a point where flow velocity slows. A low point or sump will be the location where sedimentation occurs. It is important to note the locations of erodible areas in the watershed so the right BMP is chosen for these areas (Map 2-5). For example, BMPs that promote infiltration and filtration will likely require a higher level of maintenance in these areas, and this may impact the recommendation of which BMP is appropriate for areas downgrade of highly erodible soils. Sediment deposition from soil erosion is the primary factor in reducing the effectiveness and functionality of stormwater BMPs.



Map 2-5. Soil Erodibility in the Deer Creek Watershed

2.23 Topography

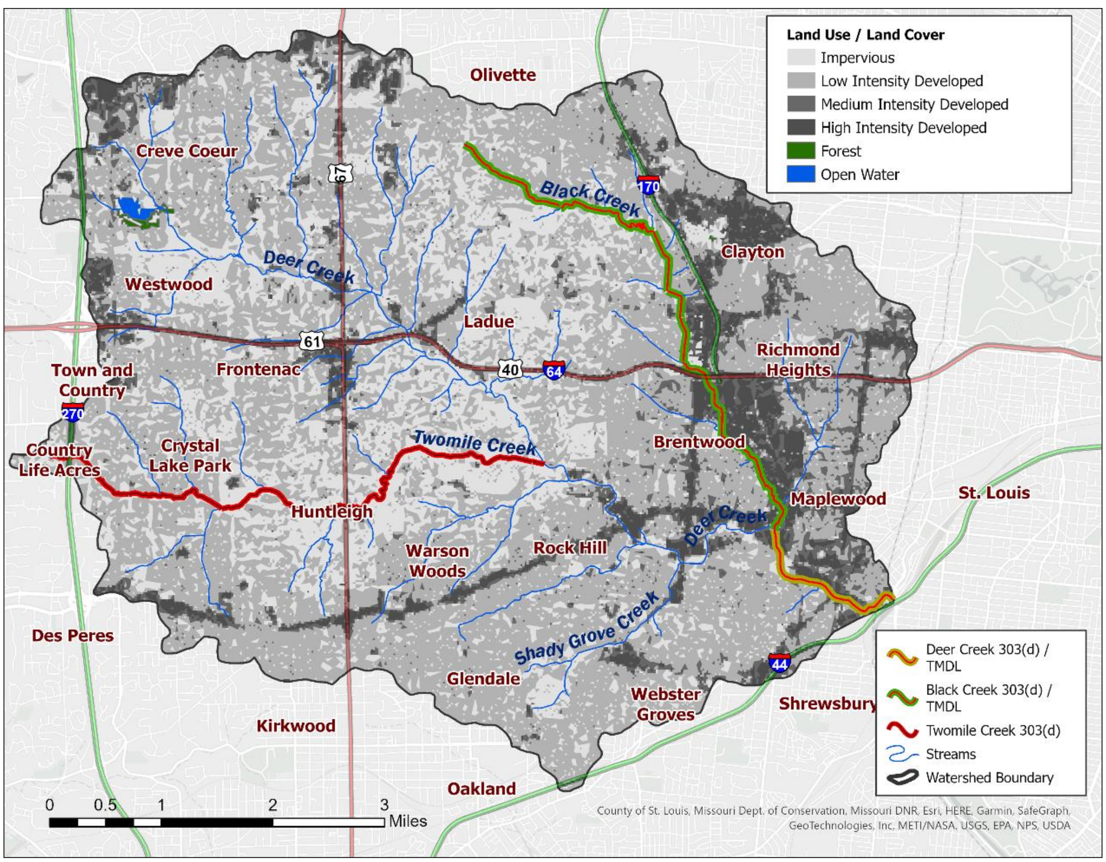
Consideration of site specific slope, infiltration rate, soil composition, erosion potential, underlying geography, contaminant, and sediment loads will influence the location and selection of stormwater BMP methods and their effectiveness, as well as the maintenance required to keep them functioning as intended.

2.24 Land Cover

Land cover characterization was made using the 2016 National Land Cover Database published by the U.S. Geological Survey, or USGS (Dewitz, J., 2019). Map 2-6 displays the distribution of the various land coverages across the Deer Creek watershed; Table 2-3 provides the areas and percentages for each land cover type. As shown in this information, the watershed is approximately

99 percent developed. About 57 percent of the watershed area is categorized as low intensity development. Areas of low intensity development have from 20 to 49 percent impervious cover and are composed primarily of single-family housing units. Areas of medium intensity development are also composed of single-family housing units, but contain from 50 to 79 percent impervious cover. Approximately 9 percent of the watershed area is in the medium intensity development category. About 6 percent of the watershed area is in high intensity development where impervious cover is 80 to 100 percent. According to the Metropolitan St. Louis Sewer District, actual imperviousness of the watershed is approximately 33 percent. This amount of imperviousness in the Deer Creek watershed is significant, because stream degradation associated with imperviousness has been shown to first occur at about 10 percent imperviousness and to increase in severity as imperviousness increases (Arnold and Gibbons 1996; Schueler 1994).

Areas of less imperviousness are also found in the watershed, but much of these areas are still associated with some degree of development. Approximately 27 percent of the watershed area is developed open space, which is composed primarily of lawn grasses such as those found in parks, yards, and golf courses, or planted for erosion control and aesthetic purposes. Impervious surfaces in these areas are still common, but account for less than 20 percent of the cover. Vegetated areas that are less susceptible to runoff and are typically more permeable than developed areas, in this case forest and wetlands, account for only 0.1 percent of the watershed's land cover.[4]



Map 2-6. Land cover in the Deer Creek Watershed

[4] Appendix 2-A Bacteria TMDL pgs. 6-7

Table 2-3. Land cover areas and percentages in the Deer Creek Watershed

Land Cover	*mi² (km²)*	*Percentage*
High Intensity Developed	2.4 (6.1)	6.4
Med Intensity Developed	3.4 (8.7)	9.1
Low Intensity Developed	20.9 (54.2)	56.9
Open Space - Developed	10.1 (26.0)	27.1
Forest	0.03 (0.1)	0.1
Wetland	0.003 (0.01)	0.01
Open Water	0.04 (0.1)	0.1
Total:	***36.8 (95.2)***	

2.3 Hydrology

Changes in land cover have influenced the hydrology of the watershed. Like most streams in urbanized areas, Deer Creek suffers from a dramatically altered hydrology characterized by flash flood events during times of heavy rains and by channel fragmentation during dry periods. Historically, Deer Creek was a perennial flowing stream throughout most parts of its watershed. Deep-rooted perennial plants with extensive fibrous root systems from native prairie, oak savannah, and oak woodlands that comprised much of the vegetative cover in this area prior to European settlement would have permitted rains to soak into the soil, entering into the groundwater system and slowly charging the creek with water. High-water events after a heavy rain would be characterized by a gradual rise and recession of water in the streambed. The U.S. Geological Survey (USGS) stream gaging stations document the rapid rise and fall of stream levels in Deer Creek (Figure 2-1).

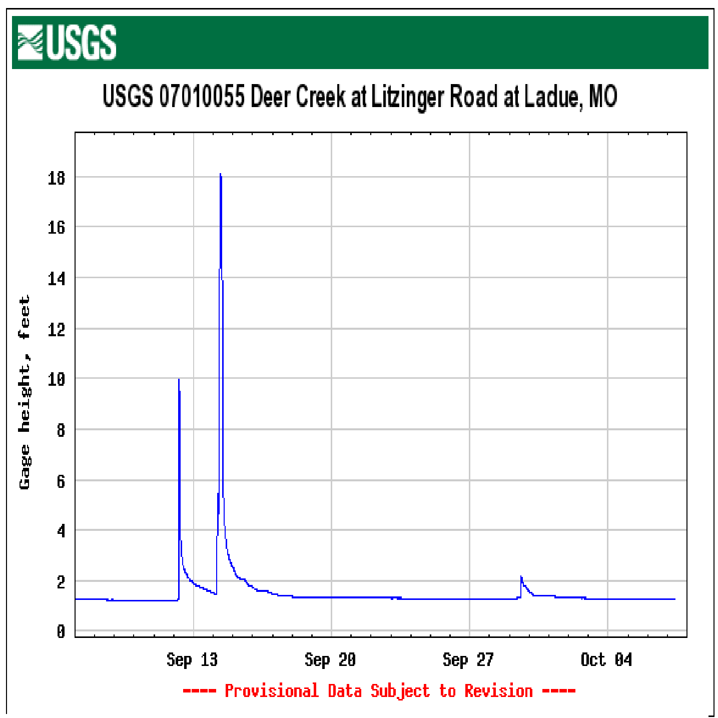


Figure 2-1. Gage height on Deer Creek in Ladue, MO

2.31 Rainfall and Climate

Weather stations provide useful information for developing a general understanding of climatic conditions in a watershed. The St. Louis Science Center weather station is the closest source to the Deer Creek watershed with recent and available weather and climate data (Figure 2-2). This station records daily precipitation and maximum and minimum temperature data, which are expected to be representative of conditions in the Deer Creek watershed. Precipitation is an important factor for stream flow and runoff events that can influence certain pollutant sources that may contribute bacteria loads. Figure 2-2 and Table 2-4 provide the annual average precipitation and annual average minimum and maximum temperatures from 1981 through 2010. [5]

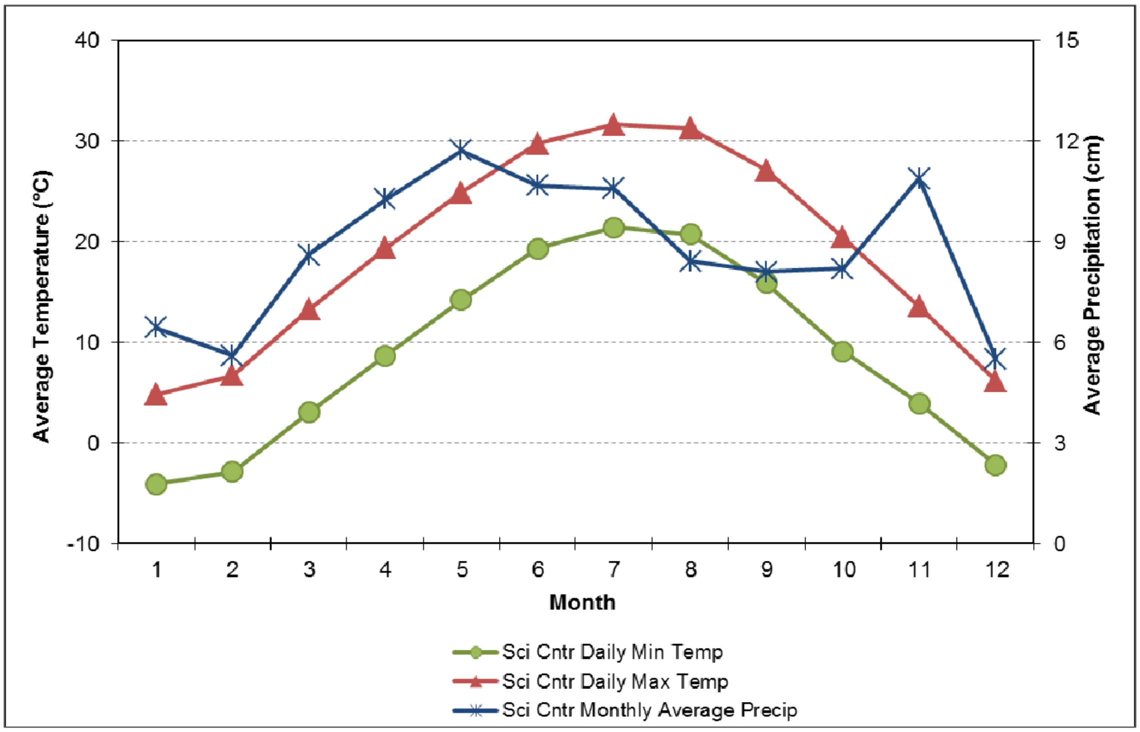


Figure 2-2 and Table 2-4. 30-year climate data from the St. Louis Science Center weather station (NOAA 2011)

Weather Station	Annual Average Precipitation cm (inches)	Annual Average Minimum Temperature °C (°F)	Annual Average Maximum Temperature °C (°F)
St. Louis Science Center	104.9 (41.29)	8.9 (48.0)	19.1 (66.3)

[5] Appendix 2-A Bacteria TMDL pg. 5

2.32 Riparian Corridor

A geomorphic study conducted by Intuition & Logic, Inc. for the Litzsinger Road Ecology Center found that prior to 1953, much of the Deer Creek Watershed from the center (at mile 5) north to highway 40/64 was undeveloped forest. Over the next thirty years, suburban development converted the forest to large residential lots and the channel was straightened to eliminate nearly 1,000 linear feet of stream. Hardening of the stream banks and straightening of the channel also contributed negatively to the health of Deer Creek by increasing the velocity of water and disconnecting the stream channel from its floodplain. Similar changes have occurred in smaller tributary streams, all of which serve to increase volume and time of concentration in flood events.

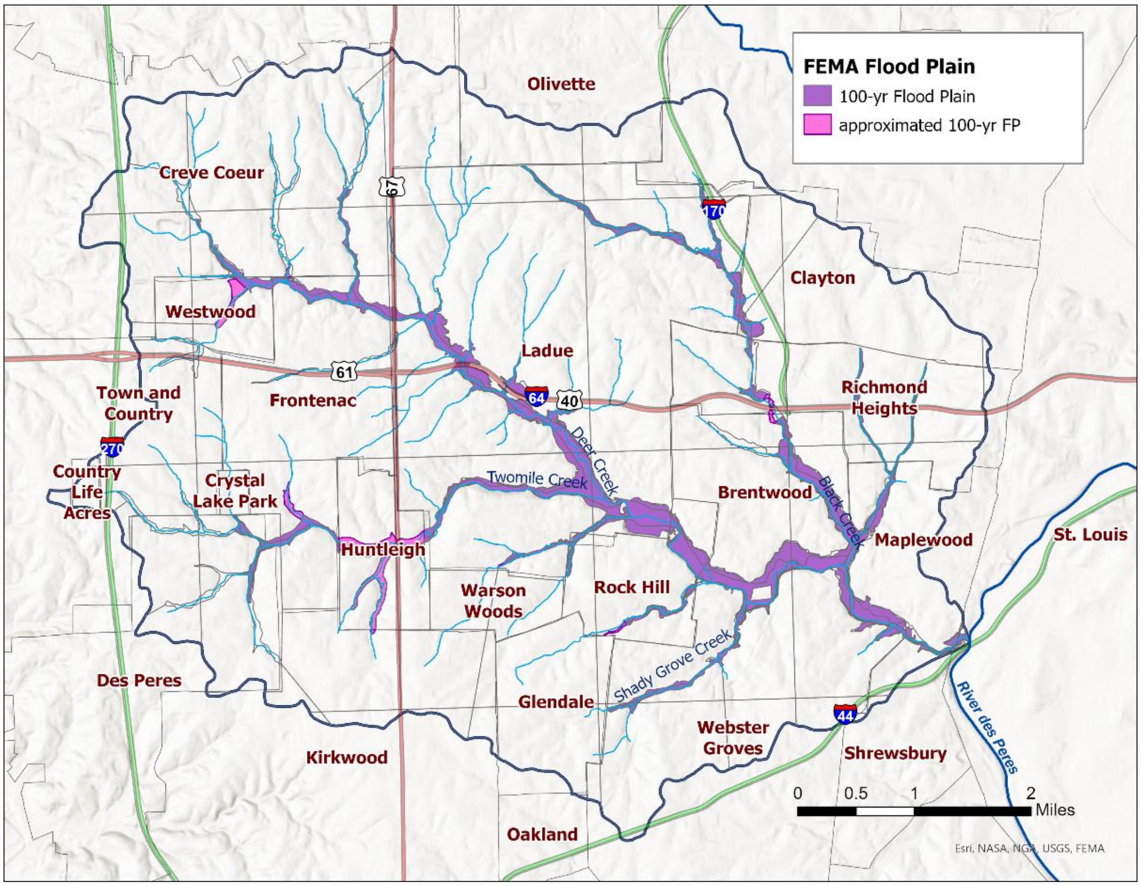
Many parts of the stream bank along Deer Creek are highly eroded and the stream has become incised and wider in places. Remarkably, Deer Creek still maintains its more natural flow in certain areas where it has room to move. For example, in the area of the Litzsinger Road Ecology Center, managed by Missouri Botanical Garden, five meanders, or bends, represent the natural way in which water tends to flow as it is pulled by gravity, following the path of least resistance. These meanders also serve an important function in the dynamics of the stream by helping to create in-stream habitat such as riffles, runs, and pools. This natural flow with meanders and bends is possible because the natural riparian buffer is greater than 100 feet throughout the LREC and its 2,500 linear feet of stream channel.

A sixth meander at the ecology center was severed by powerful floodwaters in 2016. Man-made influences on Deer Creek, such as more surface area in the watershed being converted to impervious surfaces from suburban development, are continually increasing the velocity and volume of storm water during flood events. The creek is now threatening to sever or cut off yet another of the five remaining meanders.

Partially due to impervious surfaces that include infrastructure designed to convey flow to the stream as quickly as possible during rain events, tributary streams within the Deer Creek watershed are currently experiencing rapid rises, even after small rain events, and tend to be flashy. The U.S. Geological Survey stream gaging stations document the rapid rise and fall of stream levels (Figure 2-1 above and Appendix 1A). Currently, the stream is forced to transport much larger amounts of water and sediment through its banks, during small rain events. In large storms, the Creek and its tributaries flood beyond their banks. Major floods have occurred in Deer Creek on six occasions in the last half-century: April 1973, April 1979, July 1991, September 2008, December 2015, and August 2016. In vulnerable areas, flooding is more frequent. For example, stormwater flooding has inundated the area along Deer Creek between Hanley Road and South Brentwood Boulevard 26 times since 1957.

2.33 FEMA Floodplain

Significant development has been permitted in the flood plain of Deer Creek and its tributaries. This development occurred before the adoption of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) and the National Floodplain Insurance Program (NFIP) by the cities and county. A majority of the structures affected by floodwaters include commercial and industrial structures, such as manufacturing buildings, industrial parks, warehousing, and distribution centers. A few retail shops and residences are also in the floodplain. In September 2008, flash flooding on interior streams did significant damage in St. Louis County impacting 302 commercial properties. The City of Brentwood, which is entirely in the Deer Creek Watershed, experienced 45% of the commercial property damage of the county as a whole (Wilson, 2008). Map 2-7 outlines the 100-Year Flood Zone in the Deer Creek Watershed[6].



Map 2-7. FEMA Flood Plain Map Deer Creek

2.4 Flora and Fauna

The Deer Creek Watershed is located in the middle of a major metropolitan area with a total population of 2.5 million, and yet the creek and riparian corridor provides important habitat and functions as a travel corridor for an assortment of wildlife species, such as deer, coyotes, fox, raccoon, mink, great blue herons, kingfishers, various ducks, turtles, fish, frogs, and macro-invertebrates.

Although large lots in the central portion of the watershed provide minimally disturbed habitat for wildlife, many parts of the stream bank, backyards, and other natural areas throughout the watershed have been overtaken by invasive species of plants. The most prominent invasive species

[6] https://www.fema.gov/flood-maps

in our region is *Lonicera maackii*, commonly called Amur honeysuckle or bush honeysuckle, which displaces other plants and reduces the quality of the habitat for birds and mammals.

Large lots in the watershed offer an excellent opportunity for implementing rain gardens, planting trees, removing invasive plant species, and other rainscaping or green infrastructure BMPs. Rainscaping improves water quality by holding back and removing runoff and the non-point source pollutants (including *E. coli*) it carries, as well as reducing the velocity that also contributes to erosion and sedimentation problems.

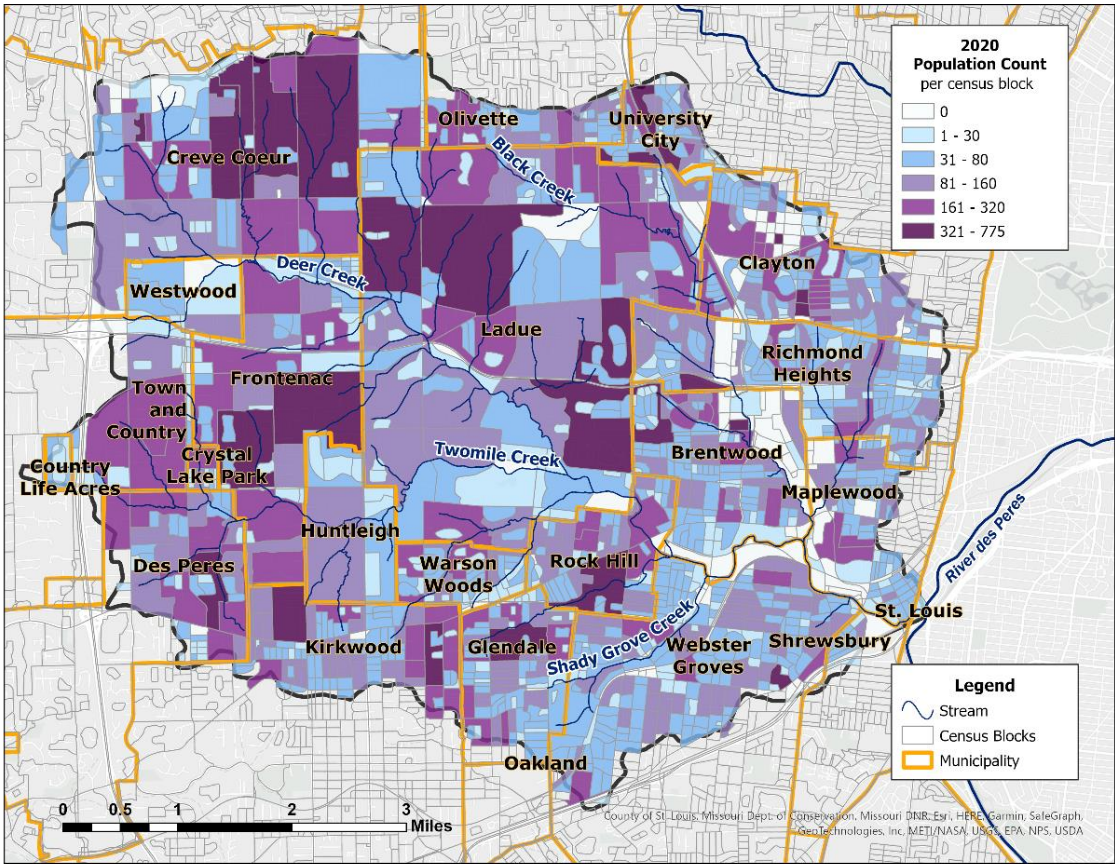
2.5 Demographic Characteristics

2.51 Political Demography

The Deer Creek watershed lies completely within central St. Louis County, (~2,513 persons per square mile) and includes all or parts of 21 municipalities. The number of municipalities involved in land management decisions in the watershed complicates watershed planning. MSD is recognized as the coordinating authority for the Phase II stormwater permit, but each of the co-permittees also has responsibilities under the permit. MSD operates and maintains a storm water system and administers stormwater regulations and oversight. The individual cities control planning, zoning, and are the floodplain administrators among other responsibilities within their boundaries. In addition, Missouri Department of Natural Resources, U.S. Army Corps of Engineers, Great Rivers Greenway District, East West Gateway Council of Governments, St. Louis County and St. Louis County Municipal League each have jurisdictional or regional planning roles in the watershed.

2.52 Population

St. Louis County covers an area of 1,355 km^2 (523 mi^2) and has a population of 1,013,888 people (U.S. Census Bureau 2020). The population of the Deer Creek watershed is not directly available; however, using U.S. Census Bureau census block data from 2020, the population of the Deer Creek Watershed is estimated to be approximately 96,504 (Map 2-8). This estimation was completed by using GIS software and superimposing the watershed boundary over a map of census blocks. Where the centroid of a census block fell within the watershed boundary, the total population for the block was included in the watershed total. If the centroid of the census block was outside the watershed boundary, then the population data was excluded. This densely populated watershed is entirely contained within a U.S. Census Bureau defined urban area. EPA defines urban areas as entities requiring stormwater regulations through municipal separate storm sewer permits (EPA 2014a).



Map 2-8. Population count per census block from 2020 Census across the Deer Creek Watershed

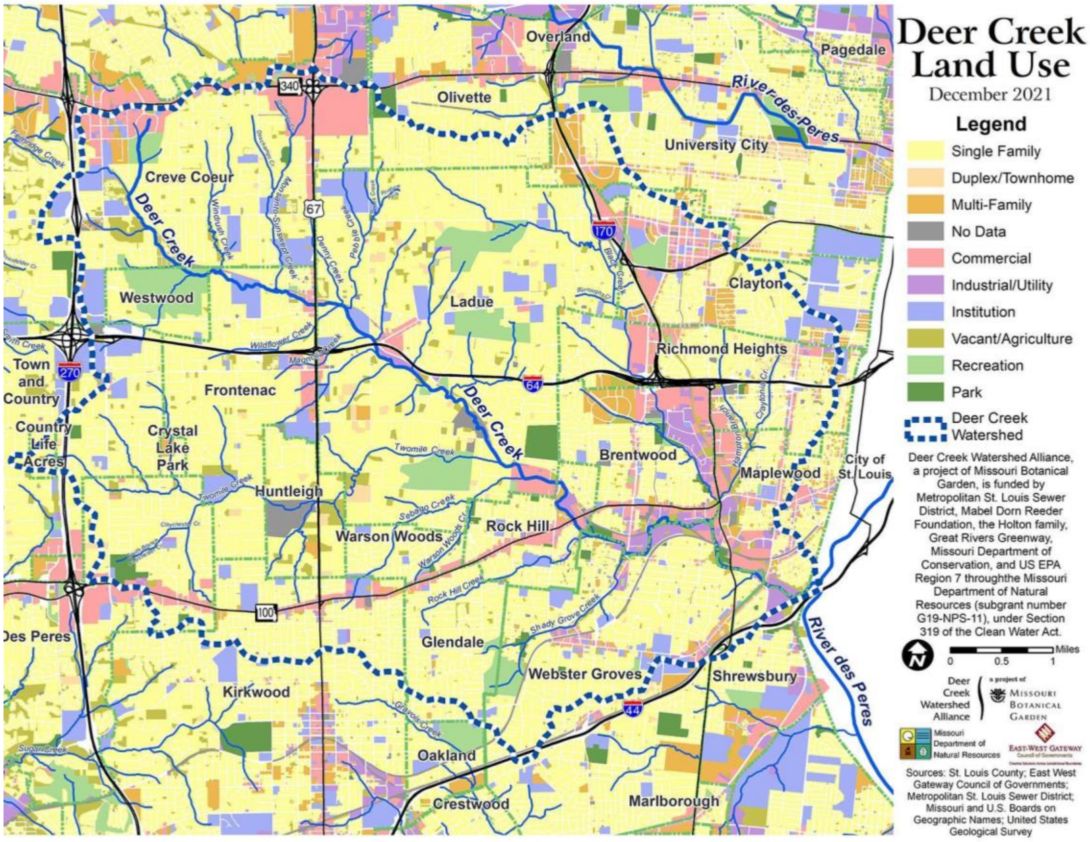
EPA completed a separate population analysis for purposes unrelated to this watershed plan. They used demographic and census block data and a web-based tool called EJSCREEN https://ejscreen.epa.gov/mapper/ to determine areas of the state having potential Environmental Justice concerns. EPA defines Environmental Justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies (EPA 2014b). Environmental Justice Communities may qualify for financial and strategic assistance for addressing environmental and public health issues (EPA 2011a). From this analysis, EPA determined that the Deer Creek watershed has potential Environmental Justice concerns for up to five percent of its area. [7]

2.53 Land Use

Land use in the Deer Creek Watershed in 2021 is reflected in Map 2-9. The watershed is 67% residential, primarily made up of single-family homes. In addition, 10% of the watershed is allocated for park, recreational or agricultural open space; 10% of the watershed is used for commercial/

[7] Appendix 2-A Bacteria TMDL pg. 6

industrial purposes, 7% of the land is owned by institutions, 4% is multi-family or duplex/townhome, and there is no data for 2% of the land area.



Map 2-9. Land use in the Deer Creek Watershed
Source: East-West Gateway Council of Governments

2.54 Economics

The St. Louis county population as a whole grew rapidly from 1960 to 1990, but since that time growth rates have flattened out and even declined slightly. The Deer Creek watershed is situated in the center of the county and with a diversity of cities that represent and experience the general trends of the county.

The Deer Creek area is predominantly residential, however the floodplain areas of Deer Creek and Black Creek have a variety of small businesses and light industry, most of which have been there for several decades or longer.

Sources of Information

Federal Emergency Management Agency Flood Maps www.fema.gov/flood-maps

East-West Gateway Council of Governments www.ewgateway.org

Federal Emergency Management Agency Flood Map Service Center https://msc.fema.gov/portal/home

Metropolitan St. Louis Sewer District Project Clear https://msdprojectclear.org/

Missouri Department of Natural Resources Total Maximum Daily Load (TMDL) for Black Creek and Deer Creek https://dnr.mo.gov/env/wpp/tmdl/docs/tmdl-bacteria-deercr-and-blackcr-final.pdf

Missouri Spatial Data Information Service www.msdis.missouri.edu

St. Louis County Department of Planning GIS Service Center www.co.st-louis.mo.us/plan/gis/

U.S Census Bureau https://www.census.gov/

U.S. Department of Agriculture Geospatial Data Gateway http://datagateway.nrcs.usda.gov/

U.S. Geological Survey - National Land Cover Database https://www.usgs.gov/centers/eros/science/national-land-cover-database

University of Missouri Center for Applied Research and Environmental Systems (CARES) Watershed Evaluation and Comparison Tool www.cares.missouri.edu